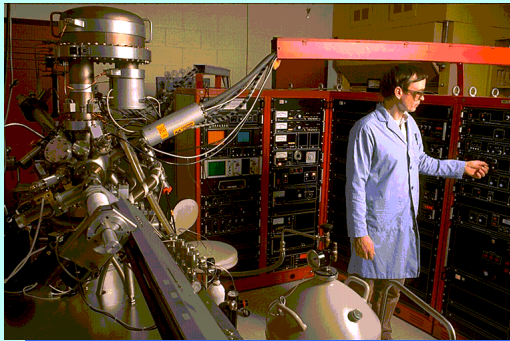
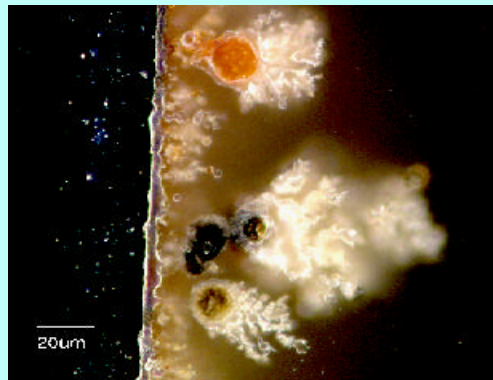


Advanced Research Program

Robert Romanosky



UCR Conference



Advanced Research program

- **The Advanced research Program is cross-cutting and is an integral part of the Advanced Power Systems, Environmental Systems, and Fuels and Industrial Systems Programs.**
- **Program Drivers:**
 - Global Climate Change: The international agreement to reduce CO₂ to 7% below 1990 levels is evolving as the most formidable challenge to the continued use of coal.
 - Environmental Regulations: In the quest for a cleaner, healthier world, governments may enact new and more stringent regulations affecting SO₂, NO_x and particulates.
 - Competing Fuels: Coal faces a major challenge from natural gas.

ADVANCED RESEARCH PROGRAM

MISSION

- The Office of Fossil Energy's Advanced Research Program serves as a bridge between basic research and the development and deployment of innovative systems capable of improving the efficient and environmentally responsible supply and utilization of fossil energy resources.
- The program leads the quest to identify breakthrough technologies or novel applications of existing technologies.
- The program provides a link for Fossil Energy to advanced research programs in national laboratories, industry, and universities.

Advanced Research Program Goals

- **Provide the basis for a series of Advanced Technologies for deployment where power and fuels must be provided in a carbon constrained environment.**
- **Explore “Grand Challenges” which address barriers to the more effective use of domestic fossil resources.**

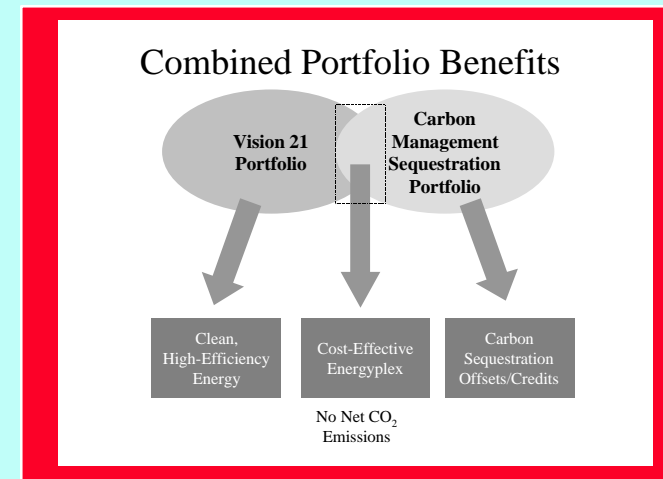
AR&TD Program Measures of Success

- **Quality of enabling science and technologies transferred to engineering development product lines.**
- **Suitability of research to address customer needs**
- **Timely and seamless transitions of research to line programs for development**
- **Co-ordination with other research organizations within and outside DOE**

Advanced Research

MISSION: Develop revolutionary technologies and processes to provide “leapfrog” improvements in coal-based power, environmental, and fuel systems (Advanced Research and Technology Development - AA2015).

- Vision 21 energyplex strategy - 65% efficient plant with zero CO₂ emissions
- Coal science and University research
- Materials and bioprocessing research
- Coal fuels research
- SBIR / STTR
- HBCU



AR&TD Program Areas

- Coal Utilization Science (CUS)
- Materials and Advanced Metallurgical processes
- Bioprocessing of Coal
- University Coal Research
- Historically Black Colleges and Universities/ Other Minority Institutions (HBCU/OMI)
- Small Business Innovation Research
- Advanced Clean Fuels Research

Advanced Research Focus Areas

■ Coal Utilization Science

- Long-range research needs for Vision 21 Energyplexes
- Novel CO₂ sequestration schemes
- Fundamental modeling of carbon structure to:
 - understand and predict combustion processes
 - understand growth of carbon nanostructures
- Coal/biomass co-firing studies
- Advanced controls and sensors

■ University Coal Research/HBCU

- Sources for ideas that lead to breakthrough technologies in all AR and line Programs

Advanced Research Focus Areas

■ Materials

- High temperature ceramics and intermetallics
- non-destructive evaluation technologies(NDE)
- oxide dispersion strengthening and production technology

■ Bioprocessing

- Biofiltration system for removal of NO_x from combustion streams.
- Bioconversion of coal to enhance economics and environmental acceptability
- Sequestration of CO₂ with genetically enhanced biological system.

Advanced Research Focus Areas

■ Advanced Fuels Research

- Co-production of Hydrogen and High Value Carbon Fibers
- Investigation of new processes for producing liquid fuels
- Exploration of efficient chemical storage of Hydrogen for fuel cell powered vehicles
- Molecular modelling of catalysts
- Exploration of Biomimetic pathways for production of fuels and chemicals

Advanced Research Product Benefits

■ Knowledge base to guide new, long-range strategies

- Novel concepts to quicken pace of technology innovation.
- “Virtual demonstrations” of complex systems reduce R&D expense.

■ Enabling Technologies

- Vision 21 goals of high efficiency power generation with no carbon dioxide emission
- Reduced transportation emissions from new carbon-based hydrogen storage media.
- Production of advanced ultra-clean synthetic transportation fuels.

Vision 21 Mission

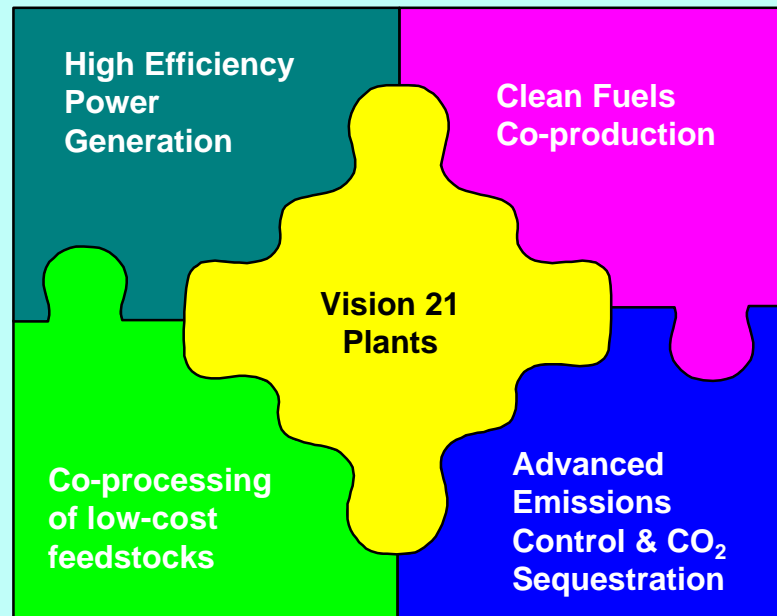
■ Development of advanced technology modules....

- that can be configured to create flexible energy plants
- can be tailored to energy market demands, including cost
- capable of over 60% efficiency in coal power generation
- capable of over 75% efficiency in gas power generation
- emitting near zero pollutants via advanced emissions control
- with options for net zero carbon dioxide
- can co-produce clean fuels and chemicals along with electricity
- can co-process low-cost feedstocks in addition to coal and natural gas

Vision 21 - Benefits

■ Benefits

- Economic, environmental, and energy security
- Portfolio of options for diverse and affordable fuel supply and use
- Environmental compliance and acceptability
- Significant contribution to climate change mitigation
- Integration of energy technologies and infrastructure



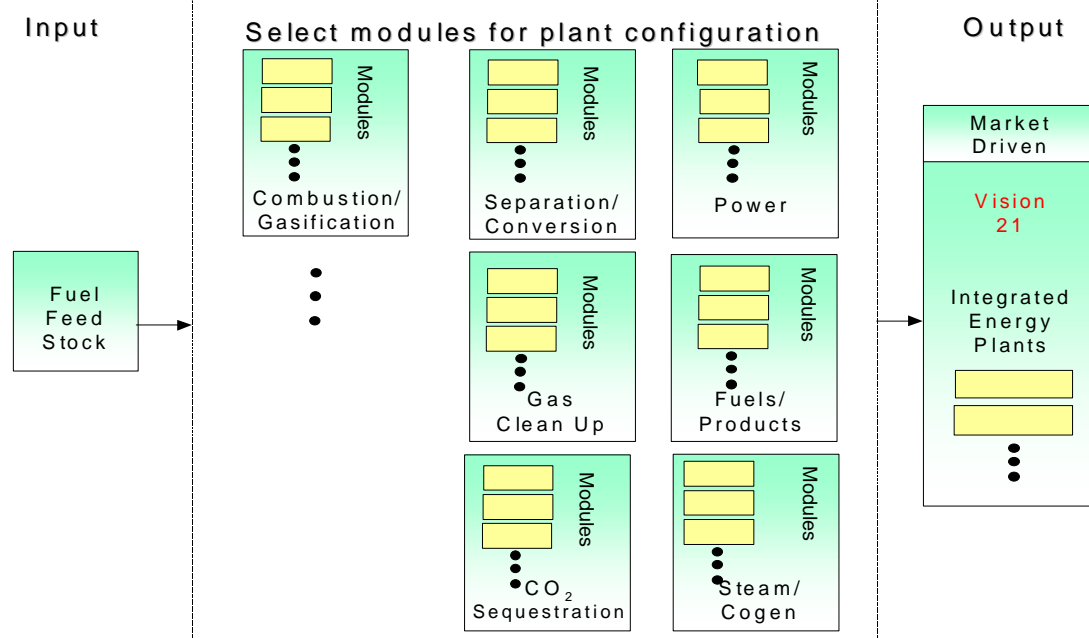
Vision 21

Benefits from the Advanced Research Program

- **Production of advanced, high-efficiency power systems that better utilize fossil fuel resources.**
- **Production of non-petroleum based liquid transportation fuels with low environmental impact.**
- **Maintain coal as the primary source of energy for electricity production.**
- **Maintain or reduce energy costs to ensure continued economic well being.**
- **Reduction of emissions to ensure human and environmental health.**

VISION 21 GENERAL SCENARIO

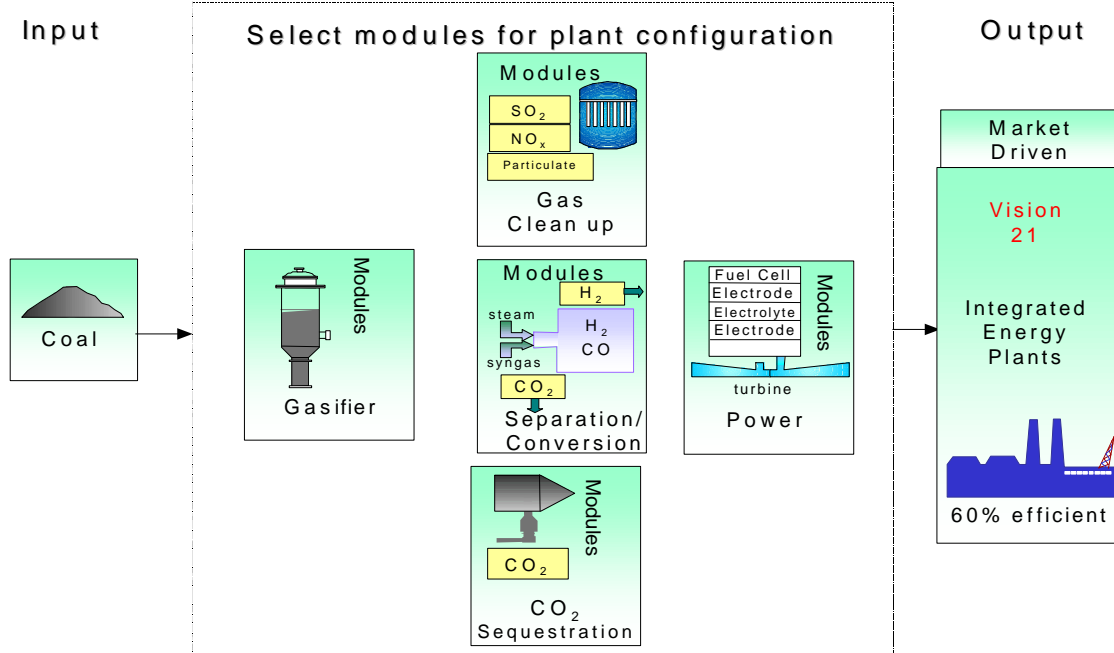
Vision 21 Concept Technology Modules



VISION 21

HIGH EFFICIENCY - POWER ONLY

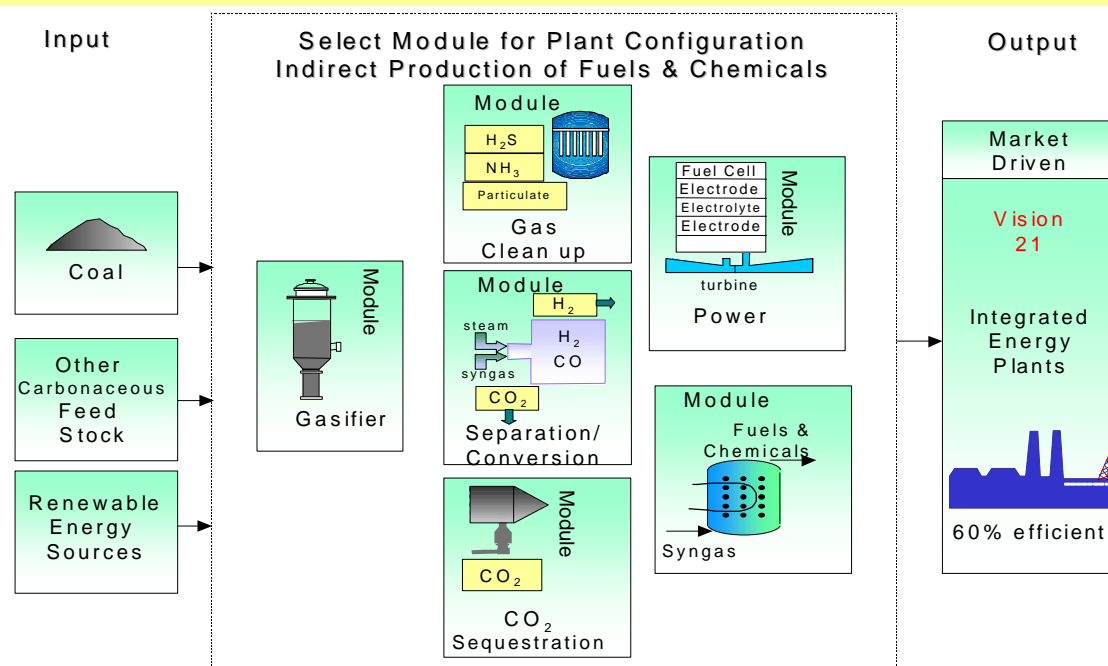
Example of Vision 21 Concept Technology Modules



VISION 21

INDIRECT PRODUCTION OF FUELS AND CHEMICALS

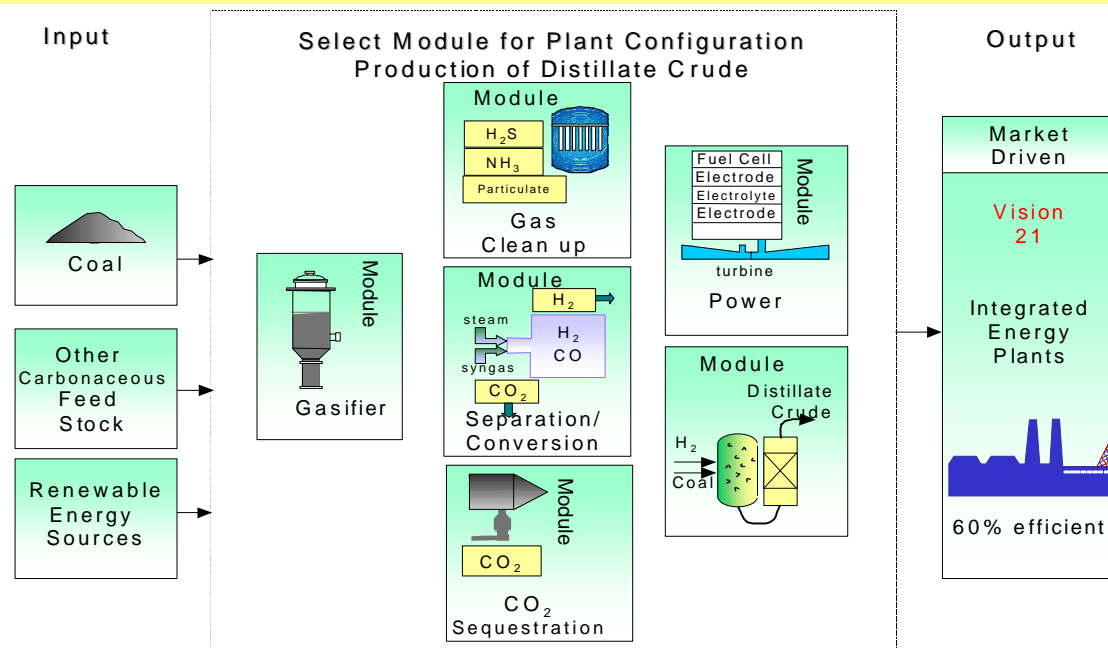
Example of Vision 21 Concept Technology Modules



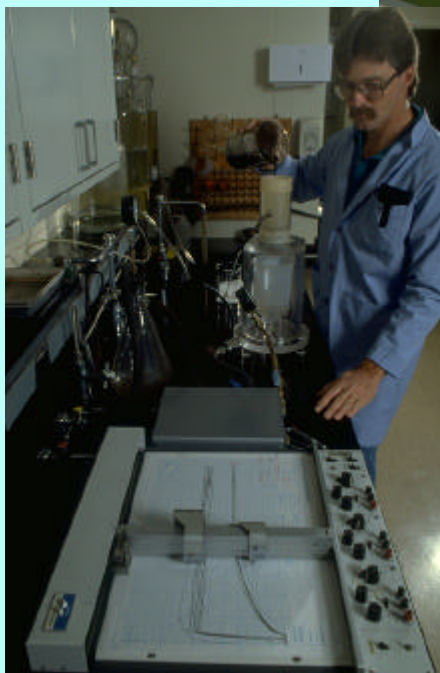
VISION 21

PRODUCTION OF DISTILLATE CRUDE

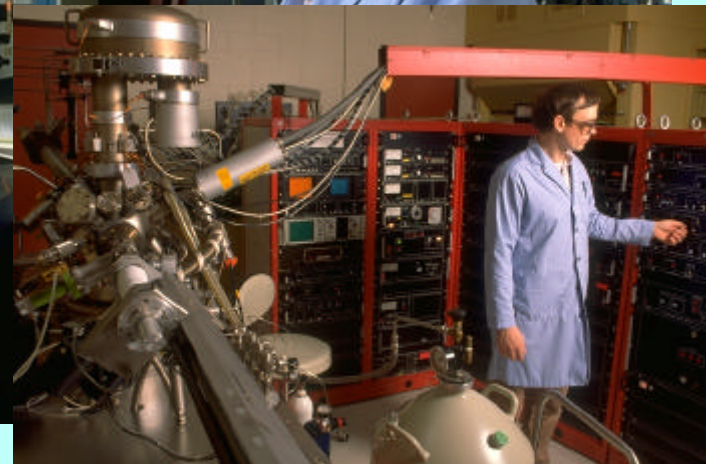
Example of Vision 21 Concept Technology Modules



Advanced Clean Fuels AR&ET



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Advanced Clean Fuels AR&ET

MISSION:

To develop technologies needed to secure an environmentally friendly, sustainable energy future; to nurture new ideas and direct research toward revolutionary improvements in advanced fuels and environmental systems; to provide a readily transferrable knowledge base of basic chemical and physical processes.

- Environment
- Economy
- Energy Security

Advanced Clean Fuels AR&ET

Major Program Thrusts

- **Advanced Fuels and Chemicals**

Solicit proposals for system-wide CO₂ management, ultra low temperature and pressure con-version operations, and H₂ production from fossil sources for fuel cell and hybrid powered autos

- **Carbon Fiber Science**

Develop nano-structured carbons for use as hydrogen storage media, catalysts, and structural elements

- **Advanced Fuel and Fuel Additive Stability Studies**

Investigate long-term storage, stability, and environmental impacts of oxygenate diesel fuels and fuel additives

- **Materials from Coal Extracts**

Develop an advanced extractive process capable of producing high value carbon products for the aluminum, automotive, aircraft and marine industries

- **Consortium for Fossil Fuel Liquefaction Science**

Investigate "energyplex" technologies where fuels, chemicals and power are coproduced from multiple carbon feestocks at the same facility

Advanced Coal-Derived Fuels and Chemicals Mission

MISSION:

Ensure the U.S. a secure energy supply at an affordable price by developing and deploying technologies that produce environmentally superior low emission fuels from coal and other carbon-based feeds (AA1010 and 1015)

- Environment
- Economy
- Energy Security

Advanced Coal-Derived Fuels and Chemicals Major Program Thrusts

- **Proof-of-Concept Testing at LaPorte (Joint with FE Natural Gas Processing and EE OHVT)**
F-T operation (FY98); DME operation (FY99)
- **Fuel/Chemicals Development**
Continue research on advanced technologies for producing high performance fuels and strategic chemicals
- **Life Cycle Analyses**
Evaluate emissions using total system approach with emphasis on CO₂; identify strategies with greatest environmental benefit
- **Pioneer Plant (Joint with IGCC)**
Solicit proposals to coproduce power and fuels (FY98); award contracts and initiate feasibility studies (FY99)
- **Innovative Process Research**
Develop methods to improve process efficiency and reduce CO₂ production

Summary

■ **The Advanced Research product line is being redirected toward:**

- **Vision 21**
- **The Hydrogen Economy**
- **Carbon Management**
- **Continuing support of ongoing programs**